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Integrating Conservation Agriculture and Irrigation Systems for Sustainable Quinoa Production in a Mediterranean Environment

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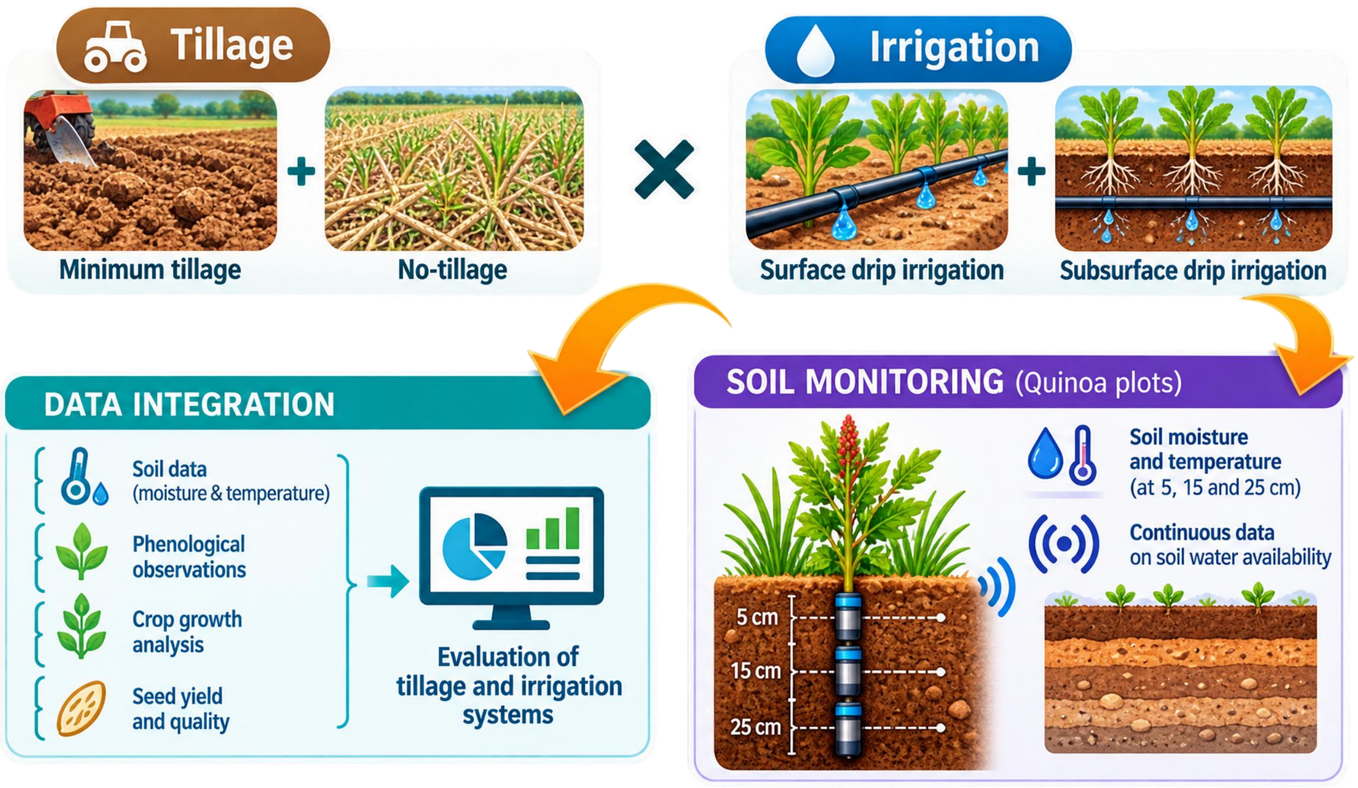
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Introduction

Water scarcity severely threatens Mediterranean agriculture, making conservation agriculture combined with drip irrigation a crucial response. To resolve root-zone hydro-thermal dynamics beyond discrete sampling, the WATERMELLON project continuously monitored soil moisture and temperature (5-25 cm) in quinoa (*Chenopodium quinoa* Willd.) across no-tillage (NT) and minimum tillage (MT) combined with surface (SUR) and subsurface (SUB) drip irrigation over 103 days at CREA-CI, Foggia.

Objectives

- Continuously monitor soil water content at different depths.
- Compare subsurface irrigation and surface irrigation.
- Test the crop response.



No-tillage: subirrigation (SUB-NT) vs surface irrigation (SUR-NT)

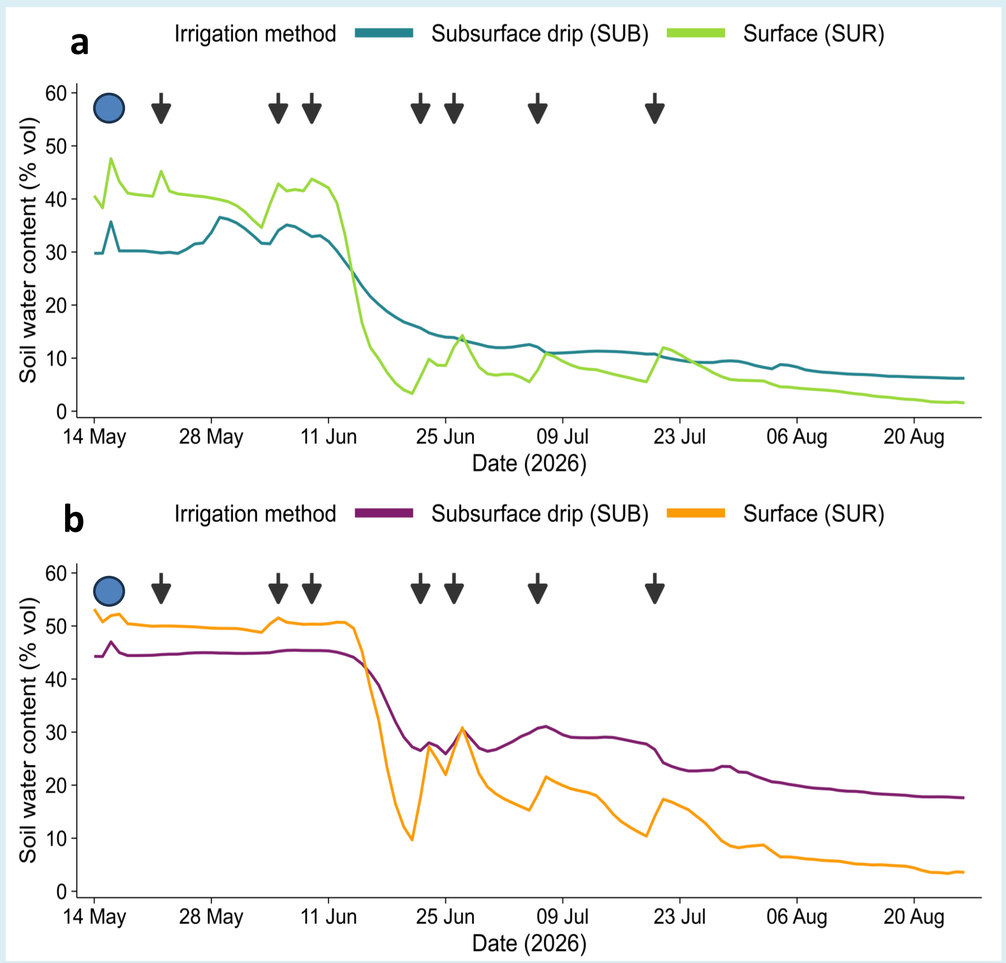


Fig. 1 Daily averages of soil water content (SENTEK probes) at 15 cm (a) and 25 cm (b) depths of two irrigation systems, Subirrigation and Surface drip irrigation, in No-Tillage long-term conservation agriculture experiment, on quinoa crop. Arrows indicate irrigation, dot is a rainfall event of 20 mm.

Materials and Methods

Factorial design: Long-term conservation agriculture experiment in quinoa plots. Layout crosses minimum tillage (MT) and no-tillage (NT) with surface (SUR) and subsurface (SUB) drip irrigation (1 probe/combination); this poster reports the two NT plots to isolate irrigation effects. **Monitoring:** Soil water content (% vol) and temperature (°C) logged every 30 minutes at 5, 15, and 25 cm from 14 May to 26 August 2026 (5 cm depth recorded but not reported here). **Irrigation:** the seven irrigations of 30mm each, and a rainfall event are reported in Fig. 1. **Data Processing:** The series were trimmed to the window common to the four probes and rounded to a half-hourly grid without duplicates, leaving 4986 records per logger, averaged into 105 daily means per probe and depth.



Results

- Winter and spring 2026 were very rainy (about 300 mm of rainfall between January and April 2026), so at the beginning of the crop cycle the soil was very wet, particularly in the deeper layers.
- After 3 irrigations (half of June), the 15 and 25 cm layers showed a reversal of soil water content between SUB and SUR in favour of SUB in the final phase of the cycle, mainly at 25 cm.
- This allowed quinoa plants under SUB to better withstand the heat waves of summer 2026 and to complete a slightly longer growing cycle than the plants under SUR (5-7 days). Yield responses are still under evaluation.

Conclusions

Continuous monitoring demonstrated that subsurface drip irrigation (SUB) sustained higher 15-25 cm soil moisture than surface drip (SUR). This deep-layer water buffering mitigated summer heat stress, delaying canopy senescence and extending quinoa's growing cycle by 5-7 days (yield pending). Ultimately, combining no-tillage (NT) with SUB optimizes root-zone hydro-thermal dynamics, offering a robust climate-adaptation strategy for Mediterranean agroecosystems.

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